B.Sc. (Honours) - Physics

Semester - I

Paper (I) - Mechanics & Oscillations (I)

(DSC HPHY 101, Credit Theory 03, Lectures 45)

Duration of EoSE : 3 hrs. **Max. Marks : 54**

Note: There will be two parts in end-semester theory paper.

Part A of the paper shall contain ten short answer questions and the candidate is required to attempt any seven questions. Each question will carry 2 marks for correct answer. **(7 x 2 marks each = 14 marks)**

Part B of the paper will consist of four questions one question from each unit with internal choice. Each question will carry 10 marks. **(4 x 10 marks each = 40 marks)**

Semester	**Code of The Course**	**Title of The Course/Paper**	**NHEQF Level**	**Credits**
I	**DSC HPHY 101**	**Mechanics & Oscillations (I)**	**5**	**3**
Level of Course	**Type of The Course**	**Delivery Type of The Course**		
Introductory	**Core**	**Lecture, Forty Five Lectures including diagnostic and formative assessments during lecture hours.**		
Prerequisites	Physics and Mathematics courses of Central Board of Secondary Education or equivalent.			
Objectives of The Course :	The objective of the course is to provide students with a comprehensive understanding of mechanics, including the laws of motion, frames of reference, forces, motion of particles and rigid bodies and rigid body dynamics. The course aims to develop their knowledge and skills in analysing and solving problems related to these topics, using appropriate mathematical formalism and physical concepts.			

Unit - I : Physical Laws & Frames of Reference

(a) Introduction to reference frames, Coordinates transformation Inertial & Non-Inertial frames, Transformation of displacement, velocity, acceleration between different frames of reference involving translation, Galilean transformation & Invariance of Newton's laws.

(b) Coriolis Force : Transformation of position, velocity & acceleration in rotating frame, Pseudo forces, Coriolis force, Motion relative to earth. **(12 Lectures)**

Unit - II : Conservation Laws & Simple Harmonic Motion (SHM)

Conservative Forces : Introduction about Conservative & Non-Conservative forces, Rectilinear motion under conservative forces, Discussion of potential energy curve & Motion of a particle, Introduction about oscillations in a potential well, Simple harmonic motion (SHM).

(11 Lectures)

Unit - III : Centre of Mass Frame

Introduction about centre of mass (CM), Centre of mass frame : Collision of two particles in one & two dimensions (elastic & inelastic), Slowing down of neutrons in a moderator, Motion of a system with varying mass, Conservation of angular momentum, Charge particle scattering by a nucleus. **(12 Lectures)**

Unit - IV : Rigid Body Dynamics

Equation of motion of a rotating body, Inertial coefficients, Case of **J** not parallel to **ω**, Kinetic energy of rotation & idea of principal axis, Calculation of moment of inertia of a disc, spherical shell, hollow & solid spheres, and cylindrical objects (cylindrical shell & solid cylinder) about their symmetric axis through center of mass. **(10 Lectures)**

Reference Books/Text Books

1. Mechanics by Charles Kittel, Berkeley Physics Course.
2. Introduction to Classical Mechanics by R. G. Takwale, P S. Puranik, TMH.
3. Classical Mechanics by Herbert Goldstein, Pearson Education.
4. Classical Mechanics by Dr. J. C. Upadhyaya, Himalaya Publishing House.
5. Analytical Mechanics by Louis N. Hand, Janet D. Finch, Cambridge University Press.
6. Mechanics by L.D. Landau and E. M. Lifshitz, Elsevier.
7. An Introduction To Mechanics, D. Kleppner, R. J. Kolenkow, 1973, McGraw-Hill.
8. Mechanics, D. S. Mathur, S. Chand and Company Limited.

Suggested E-Resources :

1. MIT OpenCourseWare: Classical Mechanics - This resource provides lecture notes, problem sets, and solutions for a complete course on classical mechanics: https://ocw.mit.edu/courses/physics/8-01sc-classical-mechanics-fall-2016/
2. HyperPhysics - This online resource provides concise explanations and interactive simulations for various topics in mechanics: http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html

Course Learning Outcomes :

By the end of the course, students should be able to:

1. Understand the concept of inertial and non-inertial frames of reference and their implications on the laws of motion.
2. Apply transformations of displacement, velocity, and acceleration between different frames of reference involving translation.
3. Explain the Galilean transformation and the invariance of Newton's laws.
4. Analyze the motion in rotating frames, including the transformation of displacement, velocity, and acceleration, and the effects of pseudo forces such as the Coriolis force.
5. Analyze the motion of a Foucault pendulum and understand its relation to the rotation of the Earth.
6. Define conservative and non-conservative forces and analyze rectilinear motion under conservative forces.
7. Analyze potential energy curves and understand the motion of particles under conservative forces.
8. Explain the concept of the center of mass and its relevance in the motion of systems of particles.
9. Apply the concept of conservation of angular momentum and analyze particle scattering by a nucleus.
10. Understand the equations of motion for rotating bodies and the concept of the moment of inertia.
11. Analyze the kinetic energy of rotation and the motion of spinning tops.

B.Sc. (Honours) - Physics

Semester - I

Paper (II) - Electromagnetism (I)

(DSC HPHY 102, Credit Theory 03, Lectures 45)

Duration of EoSE : 3 hrs. **Max. Marks : 54**

Note: There will be two parts in end-semester theory paper.

Part A of the paper shall contain ten short answer questions and the candidate is required to attempt any seven questions. Each question will carry 2 marks for correct answer. (7 x 2 marks each = 14 marks)

Part B of the paper will consist of four questions one question from each unit with internal choice. Each question will carry 10 marks. (4 x 10 marks each = 40 marks)

Semester	Code of The Course	Title of The Course/Paper	NHEQF Level	Credits
I	DSC HPHY 102	Electromagnetism (I)	5	3
Level of Course	**Type of The Course**	**Delivery Type of The Course**		
Introductory	**Core**	**Lecture, Forty Five Lectures including diagnostic and formative assessments during lecture hours.**		
Prerequisites	Physics and Mathematics courses of Central Board of Secondary Education or equivalent.			
Objectives of The Course :	The objective of the course is to provide students with a comprehensive understanding of the fundamental concepts and principles of electrostatics. It aims to develop their knowledge and skills in analysing scalar and vector fields, electric fields, and their interactions. The course will also cover important topics, such as, electric potential and polarization.			

Unit - I : Scalar & Vector Fields

Concept of Field, Scalar & Vector fields, Gradient of scalar field, Physical significance & formalism of gradient, Problems based on gradient of a scalar & vector function, Divergence & Curl of a vector field in cartesian coordinates system, Concept of solid angle, Gauss divergence & Stoke's theorem, Gauss law from inverse square law, Differential form of Gauss law. **(11 Lectures)**

Unit - II : Electric Field & Potential Energy

Potential energy of system of (i) Discrete N-charges (ii) Continuous charge distribution, Energy required to build a uniformly charged sphere, Classical radius of electron, Electric field due to a short electric dipole, Interaction of electric dipole with external uniform & non-uniform electric field, Potential due to a uniformly charged spherical shell, Poisson's & Laplace equations in cartesian coordinates & applications to solve the problems of electrostatics.

(12 Lectures)

Unit - III : Electric Field In Matter

Definition of moments of charge distribution, Multipole expansion, Dielectrics, Induced dipole moments, Polar & Non-polar molecules, Free & bound charges, Polarization, Atomic polarizability, Electric displacement vector, Electric susceptibility, Dielectric constant & relations between them. **(12 Lectures)**

Unit - IV : Electric Field & Electric Potential In Relation To A Sphere

Electric potential & electric field due to a uniformly polarized sphere (i) Outside the sphere (ii) At the surface of the sphere (iii) Inside the sphere.

Electric field due to a dielectric sphere placed in a uniform electric field (a) Outside the sphere (b) Inside the sphere.

Electric field-due to a charge placed in dielectric medium & Gauss's law, Clausius-Mossotti relation in dielectrics. **(10 Lectures)**

Reference Books/Text Books

1. Electricity & Magnetism by A.S. Mahajan& Abbas A. Rangwala Tata McGraw-Hill.
2. Introduction to Electrodynamics by David J. Griffith, Prentice Hall of India Pvt. Ltd. New Delhi.
3. Fundamental University Physics Vol II: Fields and Waves by Alonso/Finn, Addison – Wesley Publishers.
4. Classical Electrodynamics by J. D. Jackson, Wiley Student Edition.
5. Classical Electrodynamics : A Modern Perspective by Kurt Lechner, Springer International Publishing AG.
6. Classical Electrodynamics by P. Sengupta, New Age International Publishers.
7. Classical Electrodynamics (Revised Edition) by S. P. Puri, Narosa Publishers.

Suggested E-Resources :

1. MIT OpenCourseWare: Electrostatics - This resource offers lecture notes, assignments, and exams for a complete course on electrostatics : https://ocw.mit.edu/courses/physics/8-02sc-physics-ii-electricity-and-magnetism-spring-2011/
2. HyperPhysics - This online resource provides concise explanations and interactive simulations for various topics in electrostatics and electric fields: http://hyperphysics.phy-astr.gsu.edu/hbase/electric/elefie.html

Course Learning Outcomes :

By the end of the course, students should be able to:

1. Understand the concept of scalar & vector fields and their physical significance and demonstrate knowledge of gradient, divergence, and curl operators and their applications in electromagnetism.
2. Apply Gauss divergence and Stoke's theorems to analyze electric and magnetic fields.
3. Explain the behavior of electric fields and potential energy in different charge distributions and analyze the interaction of electric dipoles with external electric fields and calculate the resulting potentials.
4. Solve problems related to Poisson's and Laplace's equations in electrostatics.
5. Describe the behavior of electric fields in different types of matter, including dielectrics and polarized spheres.
6. Understand the concept of electric displacement, susceptibility, and dielectric constant.
7. Understand the concept of vector fields and their mathematical representation. Calculate partial derivatives, gradients, and line integrals of scalar and vector fields.
8. Apply Gauss's divergence theorem and understand the physical meaning of divergence in Cartesian coordinates. Relate divergence to the concept of solid angle and Gauss's law.
9. Apply curl to vector fields and understand its physical significance. Use Stoke's theorem to relate curl to line integrals.
10. Manipulate vector identities using the del operator and understand their applications in physics.
11. Analyze electrostatic fields and potentials due to discrete charges and continuous charge distributions. Calculate potential energy of systems of charges.
12. Apply the concept of electrostatic potential to determine the energy required to build a uniformly charged sphere and the classical radius of an electron.
13. Analyze the potential and field due to a short dipole in polar and Cartesian coordinates. Calculate the torque and force on a dipole in an external field.
14. Investigate magnetic forces, the measurement of charge in motion, and the invariance of charge. Analyze the electric field measured in different frames of reference.

B.Sc. (Honours) - Physics

Semester - I

Paper (III) - Optics (I)

(DSC HPHY 103, Credit Theory 03, Lectures 45)

Duration of EoSE : 3 hrs. **Max. Marks : 54**

Note: There will be two parts in end-semester theory paper.

Part A of the paper shall contain ten short answer questions and the candidate is required to attempt any seven questions. Each question will carry 2 marks for correct answer. (7 x 2 marks each = 14 marks)

Part B of the paper will consist of four questions one question from each unit with internal choice. Each question will carry 10 marks. (4 x 10 marks each = 40 marks)

Semester	Code of The Course	Title of The Course/Paper	NHEQF Level	Credits
I	DSC HPHY 103	Optics (I)	5	3
Level of Course	**Type of The Course**	**Delivery Type of The Course**		
Introductory	**Core**	**Lecture, Forty Five Lectures including diagnostic and formative assessments during lecture hours.**		
Prerequisites	Physics and Mathematics courses of Central Board of Secondary Education or equivalent.			
Objectives of The Course :	The objective of the course is to provide students with a comprehensive understanding of the fundamental concepts and principles of optics. It aims to develop their knowledge and skills in analysing basic phenomenon of interference, far- and near-field diffraction phenomena, polarization phenomenon and applications, as well as basics of lasers and holographic applications.			

Unit - I : Interference

Introduction, Coherent sources, Concept of spatial & temporal coherence, Interference in thin films, Wedge-shaped film, Newton's rings, Determination of wavelength & refractive index by Newton's ring, Michelson's interferometer, Fringes of different shapes with Michelson's interferometer, Determination of wavelength, Difference between two close wavelengths & refractive index by Michelson's interferometer, Fresnel's biprism experiment, Determination of fringe width & wavelength by Fresnel's biprism experiment. **(12 Lectures)**

Unit - II : Diffraction - Fresnel's Class of Diffraction

Introduction, Conditions for diffraction, Fresnel's assumptions, Fresnel class of diffraction, Half-period zones, Zone plate, Diffraction due to circular aperture, Straight edge, Rectangular slit, Thin wire. **(10 Lectures)**

Unit - III : Diffraction - Fraunhofer Class of Diffraction

Fraunhofer diffraction at a single slit & circular aperture, Intensity distribution & width of central maxima, and determination of slit size, Two slits diffraction & intensity distribution with missing orders, Diffraction due to N-slits with intensity distributions, Plane transmission grating, Dispersion by a grating, Rayleigh's criterion of resolution, Resolving power of grating, prism, telescope & microscope. **(12 Lectures)**

Unit - IV : Polarization, Double Refraction & Optical Activity

Polarization : Plane electromagnetic waves E and B of linearly, circularly & elliptically polarized electromagnetic waves, Production & analysis of plane polarized, circularly & elliptically polarized light.

Double Refraction & Optical Activity : Nicol prism, Huygen's theory of double refraction using Fresnel ellipsoidal surfaces (no mathematical derivation), Quarter & half-wave plates, Optical activity, Specific rotation, Half-shade & Bi-quartz polarimeters. **(11 Lectures)**

Reference Books/Text Books

1. Optics by Brijlal and Subramanium, S. Chand Publishing.
2. Principles of Optics by B.K. Mathur, Gopala Printing.
3. Optics by D. P. Khandelwal, Himalaya Publishing House.
4. Introduction to Modern Optics by A. K. Ghatak, McGraw Hill.
5. An Introduction To Modern Optics by G. R. Fowels, Dover Publications.
6. Fundamentals of Optics by Ashok Kumar, D. R. Gulati& H. R. Gulati, R. Chand & Co.
7. Optical Physics South Asian Edition by A. Lipson, S. G. Lipson & H. Lipson, Cambridge University Press.

Suggested E-Resources :

1. MIT OpenCourseWare : Optics - This resource offers lecture notes, assignments, and exams for a complete course on optics : https://ocw.mit.edu/search/?q=optics
2. HyperPhysics - This online resource provides concise explanations and interactive simulations for various topics in optics : http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html

Course Learning Outcomes :

By the end of the course, students should be able to:

1. Understand the concept of interference and diffraction fields and their physical significance.
2. Demonstrate knowledge of interference, diffraction, and polarization.
3. Applications of interference, and diffraction in framework of Fraunhoffer & Fresnel diffraction phenomenon.
4. Explain the formation of Newton's rings and determination of wavelength & refractive index.
5. Explain the principle of Michelson's interferometer and determination of wavelength & refractive index.
6. Explain the concept of polarization in optics.
7. Production and analysis of different type of polarizations and their applications.
8. Solve problems related to above mentioned topics.

B.Sc. (Honours) - Physics

Semester - I

Physics Practical Lab (I)

(DSCP HPHY 111, Credits Practical 06, Practical Hours 180)

Max. Practical Marks = 150 Marks
Internal Marks = 60 Marks
External Practical Exam = 90 Marks (Duration : 4 hrs.)

Note: Out of the following experiments, 12 experiments must be done by the students in the semester.
(12 hrs. per week)

Semester	Code of The Course	Title of The Course/Paper	NHEQF Level	Credits
I	DSCP HPHY 111	Physics Practical Lab (I)	5	6
Level of Course	Type of The Course	Delivery Type of The Course		
Introductory	Core	Practical, One Hundred & Eighty Hours of Practicals including diagnostic and formative assessment during practical hours.		
Prerequisites	Physics and Mathematics courses of Central Board of Secondary Education or equivalent.			
Objectives of The Course :	1. To provide hands-on experience in conducting experiments related to electricity and magnetism. 2. To develop practical skills in using various electrical components and instruments. 3. To reinforce theoretical concepts learned in the corresponding lecture course through practical applications. 4. To enhance problem-solving and analytical skills by analysing experimental data and interpreting results. 5. To promote scientific inquiry, critical thinking, and the ability to design and execute experiments. 6. To foster teamwork and collaboration in conducting experiments and analysing results. 7. To develop skills in accurately measuring and recording experimental data.			

DSCP HPHY 111 : Physics Practical Lab (I)

The inclusion of new experiments should be intimated and approved by the Convenor, Board of Studies before the start of the academic session. It is binding to have an experimental set-up of at least ten experiments listed below. In case the number of experiments performed by the student is less than eight, his marks shall be scaled down in the final examination on a pro-rata basis. Laboratory examination paper will be set by the external examiner out of eight or more experiments available at the center.

List of Experiments : Semester - I

1. To study the variation of power transfer to different loads by a D.C. source and to verify maximum power transfer theorem.
2. To determine internal resistance of a D.C. source (source resistance) and to verify the maximum power transfer theorem by studying the dependence of power delivered to the load on load.
3. To study the transient behaviour of a RC circuit using a DC source by varying values of R and C.
4. To study the characteristics of a semiconductor junction diode and determine forward and reverse resistances.
5. To determine the specific resistance of the material of a wire using Carey Foster's bridge.
6. To determine the difference between two small resistances using Carey Foster's bridge.
7. To convert galvanometer into an ammeter of a given range.
8. To convert galvanometer into a voltmeter of a given range.
9. To study the resonance of series LCR circuit and hence to determine resonance frequency, quality factor & bandwidth.
10. To study the resonance of parallel LCR circuit and hence to determine resonance frequency, quality factor & bandwidth.
11. To study the rise and decay of current in an L-R circuit with a source of constant EMF and to determine the time constant.
12. To study the behaviour of an RC Circuits with varying resistance and capacitance using AC mains as a power source and also to determine the impedance and phase relations.
13. To study the voltage and current behavior of an LR circuit with an AC power source. Also, determine quality factor, impedance and phase relations.
14. To study the variation of a magnetic field along the axis of a current carrying circular coil, drawing the necessary curve and hence find the radius of the circular coil.
15. To perform experimental studies of OR, AND, NOT logic gates.
16. To identify various types of circuit boards, learning of circuit symbols and determine values of resistances, capacitors & inductors using colour coding.
17. Study of normal and Zener diode characteristics by making circuit on a breadboard.
18. To study the designing of electric kettle & electric iron.
19. Any experiment according to undergraduate level physics theory.

Course Learning Outcomes :

By the end of the course, students should be able to:

1. Demonstrate proficiency in using various electrical components and instruments required for conducting experiments.
2. Apply theoretical concepts of electricity and magnetism to design and execute experiments.
3. Analyze experimental data using appropriate mathematical and statistical techniques.
4. Interpret experimental results and draw conclusions based on data analysis.
5. Develop skills in accurately measuring physical quantities and recording experimental observations.
6. Communicate experimental procedures, results, and conclusions effectively in written reports.

B.Sc. (Honours) - Physics

Semester - II

Paper (IV) - Mechanics & Oscillations (II)

(DSC HPHY 201, Credit Theory 03, Lectures 45)

Duration of EoSE : 3 hrs. **Max. Marks : 54**

Note: There will be two parts in end-semester theory paper.

Part A of the paper shall contain ten short answer questions and the candidate is required to attempt any seven questions. Each question will carry 2 marks for correct answer. (7 x 2 marks each = 14 marks)

Part B of the paper will consist of four questions one question from each unit with internal choice. Each question will carry 10 marks. (4 x 10 marks each = 40 marks)

Semester	Code of The Course	Title of The Course/Paper	NHEQF Level	Credits
II	DSC HPHY 201	Mechanics & Oscillations (II)	5	3
Level of Course	**Type of The Course**	**Delivery Type of The Course**		
Introductory	**Core**	**Lecture, Forty Five Lectures including diagnostic and formative assessments during lecture hours.**		
Prerequisites	Physics and Mathematics courses of Central Board of Secondary Education or equivalent.			
Objectives of The Course :	The objective of the course is to provide students with knowledge related to oscillations, damping, coupled oscillators, and properties of materials. The lab aims to reinforce theoretical concepts learned in the classroom, develop conceptual skills, and enhance the understanding of physics principles both through sharpened theoretical skills & experimentation.			

Unit - I : Motion Under Central Forces

Introduction about central forces, Motion under central forces, Gravitational interaction, Inertia and gravitational mass, General solution under gravitational interaction, Kepler's laws, Discussion of trajectories, Cases of elliptical & circular orbits, Rutherford scattering, Relation between impact parameter & angle of scattering. **(12 Lectures)**

Unit - II : Simple & Damped Harmonic Oscillations

Spring-mass system, Mass on a spring, Torsional oscillator, LC circuit & Energy of the oscillator, Damped force & motion under damping, Damped simple harmonic oscillator, Power dissipation. **(12 Lectures)**

Unit - III : Driven Harmonic Oscillations

Driven harmonic oscillator with damping, Frequency response, Phase relations, Quality factor, Resonance, Series & parallel combinations of LCR circuit. **(10 Lectures)**

Unit - IV : Coupled Oscillations

Equation of motion of two coupled simple harmonic oscillators, Motion in normal modes, Motion in mixed modes, Transient behaviour, Electrically coupled circuits, Frequency response, Dynamics of a number of oscillators with neighbor interactions. **(11 Lectures)**

References Books/Text Books

1. The Physics of Wave and Oscillation by N.K. Bajaj, McGrow Hill Education.
2. Vibration and Waves by A. P. French, CBS Publishers.
3. Mechanics by Charles Kittel, Berkeley Physics Course.
4. Introduction to Classical Mechanics by R. G. Takwale, P S. Puranik, TMH.
5. Classical Mechanics by Herbert Goldstein, Pearson Education.
6. Classical Mechanics by Dr. J. C. Upadhyaya, Himalaya Publishing House.
7. Analytical Mechanics by Louis N. Hand, Janet D. Finch, Cambridge University Press.
8. Mechanics by L.D. Landau and E. M. Lifshitz, Elsevier.
9. An Introduction To Mechanics, D. Kleppner, R. J. Kolenkow, 1973, McGraw-Hill.
10. Mechanics, D. S. Mathur, S. Chand and Company Limited.

Suggested E-Resources :

1. MIT OpenCourseWare: Classical Mechanics - This resource provides lecture notes, problem sets, and solutions for a complete course on oscillations & waves : https://ocw.mit.edu/courses/res-8-009-introduction-to-oscillations-and-waves-summer-2017/
2. HyperPhysics - This online resource provides concise explanations and interactive simulations for various topics in oscillations & waves : http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html

Course Learning Outcomes :

By the end of the course, students should be able to:

1. Understand the motion under central forces, including gravitational interaction, and apply Kepler's laws.
2. Analyze damped harmonic oscillations and understand the effects of damping on oscillatory motion.
3. Analyze driven harmonic oscillators with damping and understand frequency response and power dissipation.
4. Explain the behavior of coupled oscillators and analyze systems of oscillators with neighbor interactions.
5. Understand the concept of free oscillations and analyze systems with one degree of freedom. Study oscillations in arbitrary potential wells and solve simple harmonic motion problems using complex exponentials.
6. Analyze mechanical and electrical systems undergoing oscillatory motion. Calculate the energy of oscillators and examine power dissipation and damping under viscous and solid friction.
7. Understand the superposition of two undamped harmonic oscillations and the concept of beats. Analyze the combination of two oscillations at right angles and study anharmonic oscillators using the pendulum as an example.
8. Study forced oscillations with damping and harmonic forces. Analyze the effect of varying the resistive term and understand transient phenomena in driven oscillators. Calculate power absorbed by a driven oscillator and examine frequency response, phase relations, and quality factor.
9. Explore resonance in electrical oscillations, series and parallel LCR circuits, and electromechanical systems such as ballistic galvanometers. Study non-linear effects in electrical devices and acoustic waves.
10. Analyze the motion of two coupled simple harmonic oscillators and derive the differential equations for stiffness or capacitance-coupled oscillators. Understand normal modes and motion in mixed modes.
11. Study the normal modes of vibration for molecules and electrically coupled circuits.
12. Investigate many coupled oscillators, including N-coupled oscillators and longitudinal oscillators.
13. Understand the concept of normal modes, calculate normal mode frequencies, and study the motion of monoatomic and diatomic lattices. Explore dispersion relations, group and phase velocities, and the effects of coupling.
14. Study the wave equation in one dimension and its solutions for elastic waves in solid rods, gas columns, and transverse waves on a string. Analyze normal modes of a two-dimensional system and waves in two and three dimensions, including spherical waves.
15. Understand the reflection and transmission of waves on a string at a boundary, including the reflection and transmission of energy. Analyze impedance matching and standing waves on a string of fixed length.
16. Calculate the energy of a vibrating string and analyze the energy in each normal mode.

B.Sc. (Honours) - Physics

Semester - II

Paper (V) - Electromagnetism (II)

(DSC HPHY 202, Credits Theory 03, Lectures 45)

Duration of EoSE : 3 hrs. **Max. Marks : 54**

Note: There will be two parts in end-semester theory paper.

Part A of the paper shall contain ten short answer questions and the candidate is required to attempt any seven questions. Each question will carry 2 marks for correct answer. (7 x 2 marks each = 14 marks)

Part B of the paper will consist of four questions one question from each unit with internal choice. Each question will carry 10 marks. (4 x 10 marks each = 40 marks)

Semester	Code of The Course	Title of The Course/Paper	NHEQF Level	Credits
II	DSC HPHY 202	Electromagnetism (II)	5	3
Level of Course	**Type of The Course**	**Delivery Type of The Course**		
Introductory	**Core**	**Lecture, Forty Five Lectures including diagnostic and formative assessments during lecture hours.**		
Prerequisites	Physics and Mathematics courses of Central Board of Secondary Education or equivalent.			
Objectives of The Course :	The objective of the course is to provide students with a comprehensive understanding of the fundamental concepts and principles of electromagnetism. It aims to develop their knowledge and skills in analysing scalar and vector fields, electric and magnetic fields, and their interactions, as described by Maxwell's equations. The course will also cover important topics such as electric potential, polarization, magnetostatics, and electromagnetic waves.			

Unit - I : Magnetostatics

Properties of magnetic field, Lorentz force, Ampere's law, Magnetic field due to a current carrying solid conducting cylinder (a) Outside (b) At the surface & (ii) Inside the cylinder, Ampere's law in differential form, Introduction of magnetic vector potential, Bio-Savart's law & application to magnetic vector potentials. **(09 Lectures)**

Unit - II : Magnetic Field In Matter

Atomic magnet, Gyromagnetic ratio, Bohr-magneton, Larmor frequency, Induced magnetic moment & diamagnetism, Spin magnetic moment, Para- & ferromagnetism, Intensity of magnetization, Magnetic permeability & susceptibility, Free & bound current densities, Magnetic field due to a uniformly magnetized material & non-uniformly magnetized material. **(12 Lectures)**

Unit - III : Maxwell's Equations & Electromagnetic Waves (A)

Displacement current, Maxwell's Equations, Electromagnetic wave equation, Electromagnetic waves & properties, Electromagnetic waves in free space & isotropic medium. **(12 Lectures)**

Unit - IV : Electromagnetic waves (B)

Electromagnetic spectrum, Energy density of electromagnetic waves, Poynting theorem, Radiation pressure & resistance in free space, Electromagnetic waves in dispersive medium.

(12 Lectures)

Reference Books/Text Books

1. Electricity & Magnetism by A.S. Mahajan & Abbas A. Rangwala Tata McGraw-Hill.
2. Introduction to Electrodynamics by David J. Griffith, Prentice Hall of India Pvt. Ltd. New Delhi.
3. Fundamental University Physics Vol II: Fields and Waves by Alonso/Finn, Addison – Wesley Publishers.
4. Classical Electrodynamics by J. D. Jackson, Wiley Student Edition.
5. Classical Electrodynamics : A Modern Perspective by Kurt Lechner, Springer International Publishing AG.
6. Classical Electrodynamics by P. Sengupta, New Age International Publishers.
7. Classical Electrodynamics (Revised Edition) by S. P. Puri, Narosa Publishers.

Suggested E-Resources :

1. MIT OpenCourseWare: Electricity and Magnetism - This resource offers lecture notes, assignments, and exams for a complete course on electricity and magnetism: https://ocw.mit.edu/courses/physics/8-02sc-physics-ii-electricity-and-magnetism-spring-2011/
2. HyperPhysics - This online resource provides concise explanations and interactive simulations for various topics in electromagnetism : http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html

Course Learning Outcomes :

By the end of the course, students should be able to :

1. Analyze the behavior of magnetic fields in various materials and the effects of currents on magnetic fields.
2. Apply Ampere's law and the magnetic vector potential to calculate magnetic fields in different scenarios.
3. Explain the properties of electromagnetic waves and their behavior in isotropic and dispersive media.
4. Calculate the energy density and radiation pressure of electromagnetic waves.
5. Understand the spectrum of electromagnetic waves and its implications.
6. Investigate magnetic forces, the measurement of charge in motion, and the invariance of charge. Analyze the electric field measured in different frames of reference.
7. Understand the magnetic field in free space and matter. Apply Ampère's circuital law and use it in differential form with the vector potential.
8. Calculate the magnetic field for different current configurations using the Biot-Savart law and deduce the field of any current-carrying wire.
9. Apply transformation relations for electric and magnetic fields between inertial frames.
10. Study electric fields in matter, including electrical moments, dipole and quadrupole moments, atomic and molecular dipoles, and dielectrics. Analyze the field of a charge in a dielectric medium and the connection between electric susceptibility and atomic polarizability.
11. Investigate electromagnetic induction, Faraday's law, and the effects of conducting rods and loops moving in magnetic fields. Understand the differential and integral forms of Faraday's law.
12. Analyze inductance, self-inductance, mutual inductance, and energy stored in inductors and magnetic fields. Understand displacement current and its role in Maxwell's equations.
13. Explore Maxwell's equations in differential and integral form, their application in material media, and the boundary conditions for electric and magnetic fields at vacuum-dielectric and vacuum-metal boundaries.

B.Sc. (Honours) - Physics

Semester - II

Paper (VI) - Optics (II)

(DSC HPHY 203, Credits Theory 03, Lectures 45)

Duration of EoSE : 3 hrs. **Max. Marks : 54**

Note: There will be two parts in end-semester theory paper.

Part A of the paper shall contain ten short answer questions and the candidate is required to attempt any seven questions. Each question will carry 2 marks for correct answer. (7 x 2 marks each = 14 marks)

Part B of the paper will consist of four questions one question from each unit with internal choice. Each question will carry 10 marks. (4 x 10 marks each = 40 marks)

Semester	Code of The Course	Title of The Course/Paper	NHEQF Level	Credits
II	DSC HPHY 203	Optics (II)	5	3
Level of Course	Type of The Course	Delivery Type of The Course		
Introductory	Core	Lecture, Forty Five Lectures including diagnostic and formative assessments during lecture hours.		
Prerequisites	Physics and Mathematics courses of Central Board of Secondary Education or equivalent.			
Objectives of The Course :	The objective of the course is to provide students with a comprehensive understanding of the fundamental concepts and principles of quantum optics and photonics. It aims to develop their knowledge and skills in coherent nature of light, its applications *viz.* typically laser and two mainstream topics of photonics of holography and fibre optics.			

Unit - I : Coherent Nature of Light

Coherent & incoherent sources, Monochromaticity & Sodium-light, Importance of coherence in applications, Coherence of LASER light, Spatial & Temporal coherence, Difference between ordinary & LASER light, Light Amplification by Stimulated Emission of Radiation (LASER) : Nature & properties, Coherence in quantum optics. **(11 Lectures)**

Unit - II : LASER

Spontaneous & Stimulated emission, Einstein's coefficients & condition to achieve laser action, Energy density of radiation as a result of stimulated emission & absorption, Population inversion, Methods of pumping, Energy level schemes, Methods to produce laser light : Ruby laser, He-Ne laser & semiconductor laser. **(12 Lectures)**

Unit - III : Holography

Basic concepts of holography & hologram, Principles of holography, Theory, construction & reconstruction of image, Applications of holography : Holographic interferometry, holographic scanners & holography in bioscience. **(10 Lectures)**

Unit - IV : Fiber Optics

Introduction to optical fiber, Necessity of cladding, Optical fiber system, Optical fiber cable & cross-sectional structure, Total internal reflection, Explanation of propagation of light through an optical fiber, Classifications : Step-index & graded-index optical fibers.

(12 Lectures)

Reference Books/Text Books

1. Optics by Brijlal and Subramanium, S. Chand Publishing.
2. Principles of Optics by B.K. Mathur, Gopalal Printing.
3. Optics by D. P. Khandelwal, Himalaya Publishing House.
4. Introduction to Modern Optics by A. K. Ghatak, McGraw Hill.
5. An Introduction To Modern Optics by G. R. Fowels, Dover Publications.
6. Fundamentals of Optics by Ashok Kumar, D. R. Gulati& H. R. Gulati, R. Chand & Co.
7. Optical Physics South Asian Edition by A. Lipson, S. G. Lipson & H. Lipson, Cambridge University Press.
8. Essentials of Lasers by Allen, Elsevier.

Suggested E-Resources :

1. MIT OpenCourseWare : Quantum Optics & Photonics - This resource offers lecture notes, assignments, and exams for a complete course on quantum optics and photonics : https://ocw.mit.edu/search/?q=quantum%20optics
2. HyperPhysics - This online resource provides concise explanations and interactive simulations for various topics in quantum optics and photonics : http://hyperphysics.phy-astr.gsu.edu/hbase/optmod/qualig.html

Course Learning Outcomes :

By the end of the course, students should be able to:

1. Understanding of the concept of coherent nature of light, monochromatism & definition of LASER.
2. Understanding of the concept of LASER, stimulated emission, spontaneous emission, Einstein's coefficients, population inversion, optical pumping.
3. Methods and production, construction of He-Ne, CO_2 & Ruby lasers.
4. Understanding of basic principles of holography, construction & reconstruction of image and applications of holography.
5. Understanding of concepts of fibre optics, total internal reflection & light propagation.

B.Sc. (Honours) - Physics

Semester - II

Physics Practical Lab (II)

(DSCP HPHY 211, Credit 06, Practical Hours 180)

Max. Practical Marks = 150 Marks
Internal Marks = 60 Marks
External Practical Exam = 90 Marks (Duration : 4 hrs.)

Note: Out of the following experiments, 12 experiments must be done by the students in the semester.
(12 hrs. per week)

Semester	Code of The Course	Title of The Course/Paper	NHEQF Level	Credits
II	DSCP HPHY 211	Physics Practical Lab (II)	5	6
Level of Course	Type of The Course	Delivery Type of The Course		
Introductory	Core	Practical, One Hundred & Eighty Hours of Practicals including diagnostic and formative assessment during practical hours.		
Prerequisites	Physics and Mathematics courses of Central Board of Secondary Education or equivalent.			
Objectives of The Course :	1. To provide hands-on experience in conducting experiments related to electricity and magnetism. 2. To develop practical skills in using various electrical components and instruments. 3. To reinforce theoretical concepts learned in the corresponding lecture course through practical applications. 4. To enhance problem-solving and analytical skills by analysing experimental data and interpreting results. 5. To promote scientific inquiry, critical thinking, and the ability to design and execute experiments. 6. To foster teamwork and collaboration in conducting experiments and analysing results. 7. To develop skills in accurately measuring and recording experimental data.			

DSCP HPHY 211 : Physics Practical Lab (II)

The inclusion of new experiments should be intimated and approved by the Convenor, Board of Studies before the start of the academic session. It is binding to have an experimental set-up of at least ten experiments listed below. In case the number of experiments performed by the student is less than eight, his marks shall be scaled down in the final examination on a pro-rata basis. Laboratory examination paper will be set by the external examiner out of eight or more experiments available at the center.

List of Experiments : Semester - II

1. To study the random decay and determine the decay constant using the statistical board.
2. Using compound pendulum study the variation of time period with amplitude in large angle oscillations.
3. To study damping using a compound pendulum/bar pendulum and determine damping coefficient & quality factor of the compound pendulum.
4. To study radius of gyration and to determine acceleration due to gravity (g) using a compound pendulum/bar pendulum.
5. To determine Young's modulus by bending of rectangular cross-sectional beam.
6. To determine Young's modulus (Y), σ (Poisson's ratio) and η (modulus of rigidity) by Searle's method.
7. To determine modulus of rigidity of a wire using Maxwell's needle.
8. To determine the Poisson's ratio of the rubber.
9. To study the variation of surface tension with temperature using Jaeger's method.
10. To find the motion of a spring and calculate (a) spring constant (b) acceleration due to gravity (g) (c) modulus of rigidity.
11. To study the sensitivity of a cathode ray oscilloscope (CRO).
12. To convert a given voltmeter to an ammeter of suitable range and calibrate the ammeter.
13. To convert a given ammeter (μA to mA) to a voltmeter of suitable range and calibrate the voltmeter.
14. To study the Fresnel's & Fraunhoffer's diffraction.
15. To study the (4x1)/(8x1) multiplexer using the digital circuit platform (IC 74139).
16. To study the excitation of normal modes and measure frequency splitting using two coupled oscillators.
17. To study the frequency of energy transfer as a function of coupling strength using coupled oscillators.
18. (a) To study the viscous fluid damping of a compound pendulum and determination of damping coefficient and Q of the oscillator.

    (b) To study the electromagnetic damping of a compound pendulum and to find the variation of damping coefficient with the assistance of the conducting lamina.
19. To find J by Callender and Barne's method.
20. To measure Curie temperature of Monel alloy.
21. To study of normal modes of a coupled pendulum system.
22. To study the simple harmonic motion (SHMs) of two perpendicularly aligned systems.
23. To determine the moment of Inertia of a fly-wheel.
24. Any experiment according to undergraduate level physics theory.

Course Learning Outcomes :

By the end of the course, students should be able to:

1. Demonstrate proficiency in using various components and instruments required for conducting experiments.
2. Apply theoretical concepts of mechanics to design and execute experiments.
3. Analyze experimental data using appropriate mathematical and statistical techniques.
4. Interpret experimental results and draw conclusions based on data analysis.
5. Develop skills in accurately measuring physical quantities and recording experimental observations.
6. Communicate experimental procedures, results, and conclusions effectively in written reports.